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Anthocyanin, phenolic composition, colour measurement and sensory analysis of BC commercial red wines

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Abstract

This research established a database of analytical values associated with 173 commercial red wines from 7 vintages (1995–2001), 4 varieties (Pinot noir, Merlot, Cabernet Franc, Cabernet Sauvignon) and 13 vineyard locations within BC. Wines were analyzed for sulfur dioxide, pH, titratable acidity, phenolics, tartaric esters, flavonols, as well as copigmented, monomeric, polymeric, and total anthocyanins. Colour was evaluated using colour density, hue, and L, a^*, b^* and chroma measurements. The sensory astringent qualities were characterized on a subset of 78 wines, using a panel of 12 judges. The panel evaluated the magnitude of the astringency, astringent aftertaste, oakiness and bitterness, as well as 3 astringent sub-qualities (surface roughness, drying, puckering). Data were analyzed by analysis of variance, principle component analyses, and canonical discriminant analyses to track the influence of variety, vintage and vineyard location. Trends were observable despite large variation in winemaking techniques. Red colour, colour density, copigmented, monomeric, polymeric and total anthocyanins were lowest in Pinot noir and highest in Cabernet Sauvignon wines. Younger wines had higher concentrations of copigmented, monomeric, and total anthocyanins than did older wines. Canonical discriminant analysis of the analytical and sensory determinations were successful in distinguishing the wines according to where the grapes were grown.

Keywords: Phenols; Anthocyanins; Colour measurement; Sensory analysis; Wine analysis

1. Introduction

Phenol composition is an important aspect in high quality red wines. Phenols are responsible for astringency and bitterness (Fischer & Noble, 1994), and play a role in colour stability (Robinson, Weirs, Bertino, & Mattick, 1966). The phenolic profile of a wine has been shown to be influenced by different viticultural practices (Price, Breen, Valladao, & Watson, 1995; Reynolds, Price, Wardle, & Watson, 1994; Yokotsuka, Nagao, Nakazawa, & Sato, 1999; Zoecklein, Gugelsang, Gump, & Nury, 1995), and different enological techniques (Sims & Bates, 1994; Wightman, Price, Watson, & Wrolstad, 1997; Zoecklein et al., 1995). The variety (Goldberg, Karumanchiri, Tsang, & Soleas, 1998), vintage (Brossaud, Cheynier, Asselin, & Moutounet, 1999; Yokotsuka et al., 1999), and region where the grapes are grown (Brossaud et al., 1999; Goldberg et al., 1998) all affect the phenolic composition of the wine.

In British Columbia (BC) there has been a concentrated effort since the mid-1980s to produce internationally competitive high quality red wines. The Okanagan Valley appellation of BC contains the highest percentage of *Vitis vinifera* plants and is considered the most ideal location within the province for the production of wine from red varieties. The topography within this valley is complex, resulting in vineyards with different slope aspects, altitudes, soil compositions and textures (Bowen et al., 2005). Climatic conditions vary from the north to the south of the valley while several vineyards are moderated by their proximity to large bodies of water. As a result of this

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geographical variation, as well as variation due to different winemaking styles, wines of a given variety within the Okanagan Valley can exhibit very different sensory characteristics. With this in mind, the objectives of this research were: (1) to contribute to an already existing database of anthocyanin, phenolic and colour measurements on BC commercial red wines, (2) to document the perceived astringency and bitterness from wine from vineyards located throughout the Okanagan Valley and (3) to investigate patterns of wine compositional and sensory analyses for vintages, varieties, and vineyard locations from within the Okanagan Valley, BC.

2. Materials and methods

2.1. Wines and wine sampling procedure

Commercial Cabernet Sauvignon, Cabernet Franc, Merlot, and Pinot noir wines were selected from wineries throughout the Okanagan Valley, BC, Canada. Vintages of these wines ranged from 1995 to 2001. In an attempt to avoid wine oxidation that could affect later sensory results, each bottle of wine was sampled for chemical analysis by partially removing the cork and inserting two gas chromatography needles. Two syringes, one full of nitrogen and the other empty, were attached to these needles, the bottle was inverted putting the needles in contact with the wine, and the nitrogen was subsequently pushed into the bottle causing a 40 ml sample of wine to be forced into the empty syringe.

2.2. Analytical determinations

2.2.1. pH and tartaric acid measurements

The titratable acidity (TA) and pH of each sample were determined through the use of a Metrohm 686 Titroprocessor (Metrohm Ltd., Switzerland) and a symphony SB21 pH meter (Thermo Orion, USA). Titratable acidity determinations, expressed in equivalent of tartaric acid content (g/L), were carried out by diluting a 10 ml aliquot of each wine with 90 ml of distilled water and subsequently titrating the sample with 0.1 N NaOH to a pH endpoint of 8.1.

2.2.2. Analysis of phenolics

In the determination of total phenolic, flavonol, tartaric ester, and anthocyanin content, a sample 0.5 ml in volume was taken from each wine and diluted to a volume of 5 ml with 10% ethanol. A 0.25 ml aliquot of each diluted sample was subsequently added to 0.25 ml of 0.1% HCl in 95% ethanol, and 4.55 ml of 2% HCl. Each sample was vortexed and allowed to stand for 15 min. The absorbance of each sample was measured in a 1 cm quartz cuvette at 280, 320, 360, and 520 nm using a Beckmann DU 640 spectrophotometer (Beckman, USA). Absorbance readings at each wavelength corresponded to total phenolic (A_{280}), tartaric ester (A_{320}), flavonol (A_{360}), and anthocyanin (A_{520}) content, which was determined from standard curves constructed using dilutions of gallic acid (in 10% ethanol), quercetin (in 95% ethanol), caffeic acid (in 10% ethanol), and malvidin-3-glucoside (in 10% ethanol) at 280, 320, 360, and 520 nm, respectively.

2.2.3. Tannin determination

The procedure for tannin determination was based on that originally developed by Hagerman and Butler (1978) and revised by Harbertson et al. Microlitres of resuspension buffer (5% triethanolamine, 5% SDS, and pH adjusted to 9.4 with HCl) was added, and the sample was vortexed for 10 min to redissolve the tannin–protein pellet. Each sample was put in a 1.5 ml cuvette, and the background absorbance was measured at 510 nm using a Beckman DU 640 spectrophotometer (Beckman, USA). One hundred and twenty five microlitre of ferric chloride reagent (0.01 N HCl and 10 mM $FeCl_3$) was added to each sample and allowed to stand for 10 min. After the 10 min incubation period, the absorbance of each sample was again measured at 510 nm. The tannin concentration in each sample was finally determined by subtracting the background and final absorbancies, and comparing the value obtained to a standard curve derived using catechin.

2.2.4. Colour determinations

Two methods were used to determine the colour of each wine sample. In the first, the spectrophotometric absorbance of the wine at 420, 520, and 700 nm was determined using a 1 mm cuvette. Colour density and hue were calculated using the following equations which incorporated corrected values for a 1 cm cuvette;

$$\text{Colour density} = [(A_{520} - A_{700}) + (A_{420} - A_{700})]$$

$$\text{Colour hue/tint} = [(A_{420} - A_{700})/(A_{520} - A_{700})]$$

The second method for colour determination utilized a CIELAB program for the spectrophotometer that determined L, a^*, b^* coordinate values for each wine sample in a 1 mm cuvette. The values of which correspond to the degree of wine lightness and the degree of red (when $a^* > 0$), green (when $a^* < 0$), yellow (when $b^* > 0$), and blue (when $b^* < 0$) colour (Ayala, Echavarri, & Negueruela, 1997).

2.2.5. Copigmented, monomeric, polymeric, and total anthocyanin determination

The copigmented, monomeric, polymeric and total anthocyanin content of each wine was determined using the colorimetric effects that SO_2 and acetaldehyde have on the forms of anthocyanins. In this procedure, 20 μl of 20% acetaldehyde was added to 2 ml of wine and the sample was allowed to stand for approximately 45 min. To another 2 ml sample of wine, 160 μl of 5% (w/v) SO_2 was added. The absorbance of each sample was measured at 520 nm in a 1 mm cuvette using a Beckman DU 640 spectrophotometer (Beckman, USA). Finally, the absorbance was determined without the addition of acetaldehyde or SO_2 at 520 nm. The following equations were utilized,